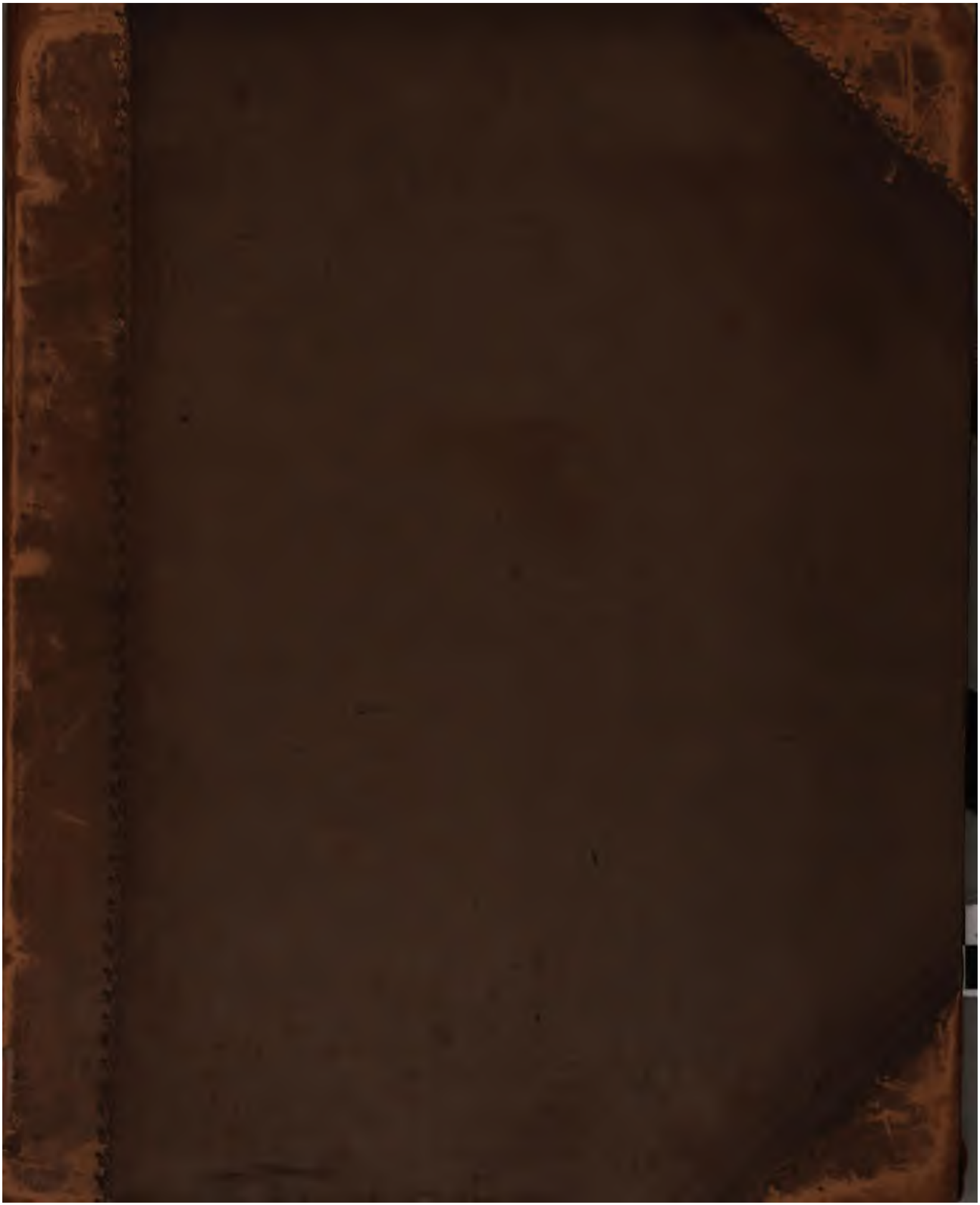

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AN ATTEMPT

TO

DEFINE THE GEOMETRIC PROPORTIONS

OF

GOTHIC ARCHITECTURE,

AS ILLUSTRATED BY THE

CATHEDRALS OF CARLISLE AND WORCESTER.

BY

ROBERT WILLIAM BILLINGS.

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1840.

LIST OF PLATES.

INTRODUCTION.

FEELING convinced that the architects of our ancient Ecclesiastical Architecture were guided in their designs and proportions by geometric principles, the author of this work puts it forth as the result of his studies upon one building, in the hope that it will meet with that kind consideration on the part of his professional brethren who feel interested in the elucidation of the elements of their art, which all reasonable theories, divested of visionary schemes, ought to command.

The application of the circle, or intersecting circles, to the plan of Gothic buildings is not new; but the application of scales, composed of a regular division of parts of that figure, fixing both the position and substance of the columns within the building, besides the various parts of the elevation, has hitherto been unknown; and the author, consequently, claims the invention or re-discovery of this principle, if it be really that which the ancient architects used, as his own. From the variety in the proportion of every part of our Cathedrals, he cannot possibly conceive how any other rule could have regulated the design.

He brings the present attempt forward for the purpose of inducing other architects to examine carefully all buildings with which they may come in contact, with the view of elucidating their principles;—to discover, if possible, the causes which produced the beautiful proportions visible everywhere in the works of our forefathers, in contradistinction to our own too frequently miserable attempts at imitation.

An eminent Architect, who has looked over the Essay, objects to the theory of scales here advanced, on account of those used in the Plan and

Elevation of Carlisle being different; but this is only imaginary, for by making the scale of the former twenty-four parts of the radius of the circle of the width, instead of eight, the scale for the elevation would be twelve parts of this scale, as each compartment is exactly one-fourth of the whole width of the Cathedral.

The circles projected on the fifth and sixth points of the present scale would then be upon the fifteenth and eighteenth points, and in the elevation of each compartment the numbers would be exactly doubled. The object, in the representations given, has been to reduce the scales to the smallest number of parts.

R. W. BILLINGS.

AN ATTEMPT,

ETC.

THE interest taken by many architects, in the geometrical analysis of the Great East Window of Carlisle Cathedral, in the author's publication on that building, has induced him to devote further attention to the subject, in order to find, if it really existed, the projection of the different parts of the Plan and Elevation of the Cathedral itself, so that an Architect by the aid of mere mechanical diagrams, without reference to any measured plans, might be enabled to project another building, either one atom larger or smaller, in perfect proportion with the original model.

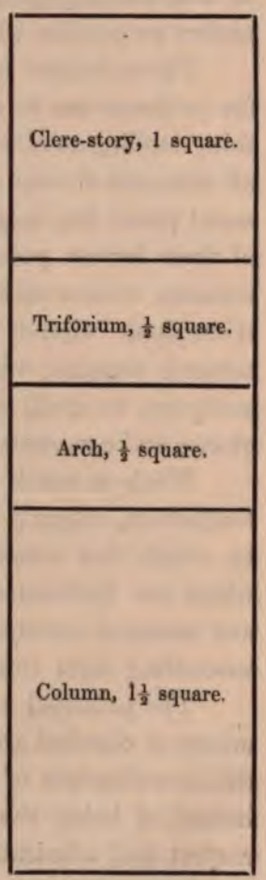
The reduction of any art, to a system, by which the time and labour of the professor can be spared, is at all times a highly desirable object, and any thing tending to elucidate its principles ought to command the attention of all admirers of that sublime science, which in countries whose political and social power has long existed but in name, alone remains to testify the genius of their former possessors, — in the contemplation of whose architectural remains, we lose sight of all their wars and conquests, and acknowledge the triumphant reign of science over the petty quarrels of man. Our own architectural remains, will render Britain celebrated when, like the nations of antiquity, we shall, in the rise and fall of states, sink into decay, and all our glories and conquests be forgotten.

While so much remains of the results of the architectural study of our forefathers, vulgarly denominated Goths, little or nothing is left of the means by which they attained that amazing union of lightness and strength, for which the Ecclesiastical Architecture of the thirteenth, fourteenth, fifteenth, and sixteenth centuries, is so justly celebrated over that of all preceding or succeeding ages to the present time.

The principal argument used against Gothic Architecture, by the admirers of classical architecture, is, that unlike the latter, it owes all the beautiful combinations of its various parts to chance or caprice of the architect, instead of being the result of fixed and harmonious proportions. With all respect and admiration of Greek and Roman architecture, are not all the

proportions of their parts, the arch excepted, rather the result of a most refined taste, instead of geometrical forms, which were undoubtedly used by the architects of the miscalled dark ages, and which appear palpably on the very face of their productions. Let it be understood that this is not meant to hint in the slightest degree against the refined beauty and perfection of the orders, the object being simply to raise the character of a style of Architecture, hitherto unfavourably put in contrast on account of its supposed want of guiding principles.

In early times, until the subversion of what is termed the Norman or circular style, it is probable, from the extreme simplicity of its forms that no intricate figures were used for regulating the proportions of the various parts; but in after times, when an extraordinary flow of lines and intricacy of geometrical forms in the tracery came into general use, can it be for a moment asked, whether such uniform beauty as is every where recognizable in the architect's productions, was the result of highly cultivated science or mere chance? All unprejudiced persons must unhesitatingly say that such results could not be produced from the latter cause.



An evidence of the simplicity just mentioned occurs in the elevation of a compartment of the Norman nave of Gloucester Cathedral, as delineated in the great folio work of the Society of Antiquaries of London, Plate XII. The massive columns, which are exceedingly lofty, are one square and a half of the width; the arch above is half a square; the triforium is half a square; and the clere-story and groining one square; making the whole internal elevation three squares and half of the width of the compartment, as marked on the margin.

Were all the proportions of Gothic buildings projected in a similar manner to this, there would evidently be no occasion for another word upon the subject; but it is a well-known fact, that the different parts of almost every one of our Cathedrals vary in the most marked manner.

Unfortunately for the students in Gothic Architecture, all drawings or designs of our ancient buildings have been most carefully destroyed, most probably by the architects themselves, who as freemasons would endeavour to keep their principles strictly secret. Had this not been the case we should certainly have discovered some of their drawings, the time of their execution only extending over a period of about six hundred years, because upon every other subject we meet with documents almost as many thousand years back. What is more to the matter, do we not meet with the builders contracts and even their bills?

Without further preface we will at once proceed to the subject of the essay, the positions of which are, that in the projection of the plans of the nave and choir of Carlisle Cathedral, the architect was guided by the repetition of a circle, whose diameter in the first or Norman part was the extreme width of the building, not including buttresses; and in the second part or choir, erected about 200 years after the nave, the diameter of the circle was the width between the internal walls; that the distribution and even the substance of the columns or piers, was regulated by some recognisable subdivision of the same circle; and lastly, that a circle, or arcs of a circle, regulated by the width of each compartment thus formed, was the basis upon which the heights of the different portions of the interior were framed, viz. the choir, columns and arches above them, the triforium, the clere-story, and ceiling. These positions we shall now endeavour to maintain by a minute examination of the proportions of this building, being the result of a survey which has occupied two years.

The system here attempted is not like the productions of system builders in general, invested with the objection that the facts are collected in order to bear out a favourite or pre-arranged theory, for here it has sprung from the opposite cause.

Before entering upon the description, let it be perfectly understood that it is not asserted that the precise divisions applied to the plan of Carlisle would answer to any other building, but that by modifications of the division of the circle, to be discovered by careful measurements and calculations, we might be enabled to fix laws for the reproduction of the great proportions of any building with the most unerring accuracy and a saving of time in the future practice of the architect, almost incredible. We do not hesitate to affirm that

the general form, and precise position of every main column in Carlisle Cathedral could be laid out in almost the time that the ground could be walked over.

As the whole of the lines worked upon the Plate of the Ground Plan of the Cathedral give it rather a complicated appearance, it has been thought advisable to display each portion of the projection separately, in order to render the subject as clear as possible. We shall now refer to fig. 1. Plate I, the commencement of the formation of the choir plan.

First, draw a right line A. A., the longitudinal centre of the intended or existing building. Upon this describe two equal circles B.B, whose circumferences touch each other; the diameter of one is the width, and of both, the extreme length from the entrance door, A. to the termination of the east wall, B. (on the engraved Plan) as appears from the following calculation.

The width from wall to wall is,

	feet	inches
The Choir - -	34	5
The Columns, each 5 3½ - -	10	7
The Aisles, each 13 6 - -	27	0
Total -	72	0

The length of the Choir is as follows;

The substance of the east wall -	6	2
First compartment - -	11	6
Second compartment - -	18	3½
Third, fourth, fifth and six ditto, 18 feet, 2 in. each	72	8
Seventh - -	18	2½
Eighth - -	13	11
Portions of the choir within the eastern piers of the tower	3	7½
Total	144	4½
The half of which is	72	2¼

or an excess of 2¼ inches over the measured width of the building.

From the junction of the circles B at C, a third circle D, of the same radius is projected, and from the extremity of each circle on the line A. A. semicircles E. E. of the same radius.

Diagram No. 2, Plate I. Lines B. B. perpendicular to A. A. cutting the

centres and intersections of these circles, gives the width of each of the eight compartments of the Choir as follows :—

Total length - - - - -	144	4½
This divided by eight gives - - -	18	0½

for the width of each compartment, which comes very close to the measurements of the parts as above enumerated. Some of the columns are rather out of their places, the second compartment from the east end being 18. 3½ wide, but this, there is little doubt, was the result of accident.

A circumstance, which rendered it exceedingly difficult at first sight in attempting a geometrical analysis of this plan, was the decreased width of the extreme compartments, but upon examination, it was found that the introduction of the eastern wall within the circle, accounted for that compartment being narrowed. The substance of the wall is 6 feet 2 inches, and the width of the compartment 11. 6, making together 17. 8; thus bringing the whole to within 4½ inches of the average width. The western compartment is 13. 11. wide, and from its extremity to the Choir door, is 3. 7½, making 17 ft. 6½ inches, wanting 6 inches of the average width. Thus the extreme compartments being narrower than the others, is in a measure, accounted for.

It is quite clear, that if the interior of the east wall had been within the circle of the width, the compartment against it would have been equal to the others; we must therefore conclude that the extreme arches were made narrower for the purpose of resisting the longitudinal thrust of those intervening.

Before dismissing this part of the subject we may as well mention a singular confirmation of the fact of the east wall being within the circle of the diameter. We allude to the body of the Temple Church, formed by two intersecting circles, whose diameter is actually guided by that of the circular portion of the church. The actual width then, of the body, should be two-thirds of its length.

The internal length is - -	85	11	
Substance of the east wall - -	3	9	
	89	8	
The third of which is - -	29	10	nearly, leaving
	59 ft. 9 inches		

for the width, which is, according to measurement, 59 feet 5 inches.

Having on the diagram, No. 2, asserted that the perpendicular lines B. B. were the limits of each compartment, we must now endeavour to prove the positions of the columns of these lines. This has been done by a scale of parts which will easily be recognized as the only one that could have been adopted here. From the result of calculations the scale has been made eight parts of the radius of the principal circle, (see Diagram, No. 3. Pl. 1.) and upon the circumference and intersection of circles from two of these parts both the position and substance of the large shafts depend. This, of course, applies to the bulk of the shaft, and not to the manner in which it may be afterwards ornamented.

The circumference of a circle, A. A. whose radius is five parts of this scale, gives the extreme width of the choir and its columns, as appears by the following calculation.

The sixteenth part of the whole diameter, (72 feet) is 4 ft. 6 in., and as this circle of five-eighths of the diameter contains ten of these parts, the width of the choir and columns should be precisely 45 feet. This agrees with the actual measurements, the choir being - 34. 5. and each column, 5 ft. 3½ in. - - 10. 7.

making a total of 45. 0.

Therefore the choir and its columns is five-eighths, and the aisles three-eighths, (or three-sixteenths each) of the entire width internally.

Another circle described upon the sixth division of the scale gives, where it intersects the perpendiculars, B. B. on each side of A., the centre of the columns at C., C., so that by drawing a right line from C. to C. through the perpendicular A, the space between D. and A. resolves the radius of the column. By repeating these circles, the position of every column is at once fixed.

A curious coincidence in the geometrical formation of this scale, is, that by repeating the diagram No. 2, forming the whole plan of the choir, upon the radius of one of the large circles, it gives all the points of the scale, as represented on No. 3.

PROJECTION OF THE NAVE.

It has been before stated, contrary to the plan adopted in the formation of the choir, where the diameter of the circle depended upon the inner wall, that the circle of the nave, or Norman portion, included the outer walls, the entire width of which is sixty-eight feet. Here the proportion of the various parts is decided, without the aid of eccentric circles, being arranged by concentric circles, regulated by a scale of parts within the principal circle. Nothing can exceed the simplicity of this projection, which is as follows: (Plate II.) Upon a given right line A. A. construct the circle of the whole width B. Divide the radius of this circle into 12 parts, and the 4th, 6th, and 8th of these, will be found to regulate the width of the nave, and the substance of its massive columns. This we can prove by the actual measurements of the Cathedral. Raise a perpendicular H., through the centre of the circle, and somewhere upon this is the position of the two columns, *a. a.* From the centre describe circles upon the fourth, fifth and sixth parts of the scale; the first of these circles describes the width of the nave, and commencement of the columns; the second decides their centres, and from the fourth to the sixth their whole substance. To fix the position of the columns, D. D. on each side of *a.*, draw the lines C. C., parallel to A. A. through the centre of the columns *a*; then upon the eighth point of the scale describe a circle, and where this intersects the lines C. C., it gives the centres of the columns, as E. E.; and circles from the 7th and 9th parts, again decide their substance. The scale of one circle therefore fixes the position of six columns, and these are, singularly enough, the only portion of the nave not destroyed by the Parliamentary troops, in 1645.

We shall now examine how far these figures agree with the actual measurements of the building. The whole width is 68 feet. The twelfth part of the radius (34 feet) is 2 ft. 10 in., and consequently the twelfth part of the diameter 5 ft. 8 in. or exactly double. In the diagram, the width of the nave is asserted to be four of these parts, or 22 feet 8 inches. By my measurement it is 22 feet 6 inches, making a difference of only 2 inches. With regard to the columns, they are exactly 5 feet 8 inches, or one twelfth of the diameter,

and it was this exact division, which induced the application of the scale of twelve parts to the diagram.

Let us now see how the position for the side columns D. D. agrees with the measurements of the building. By dropping a line G. perpendicular to A. A., from the centre of the column, we find that it touches the line A. A. at about one-fourth part of the seventh space of the scale. The two compartments therefore include six parts of the diameter, and one-fourth of the seventh, thus

Six parts, 5 ft. 8 in. each - -	34.	0.
One fourth of the seventh part or -	1.	5.
Total	35 ft.	5 in.

This ought to be the actual space of two compartments, which we give from the engraved plan of the Cathedral.

Two spaces, 12 feet each - -	24.	0.
Two columns, 5 ft. 8 in. each - -	11.	4.
Total	35 ft.	4 in.

that is varying only one inch from the theoretical measurement.

In the diagram of the projection of the nave, marked on the Ground Plan, the circle of the nave does not touch the outer wall of the south side; but this is accounted for, from its having had a thick modern casing.

ELEVATION OF A COMPARTMENT OF THE CHOIR.

We shall now proceed to examine the elevation of the choir, in every portion of which there is evidence of its geometric formation. To begin, the width of the compartment, is 18 ft. 2 in., and the height of the columns within the choir, where the floor is raised one step, the same. This part then is composed of a perfect square as shewn by the circle described within it. The diameter of the shafts is 5 ft. 3½ in. and the open space 12 ft. 10½ in.

The arch above the columns is equilateral, and exactly four-sixths of the width of the compartment, or 12 ft. 1⅓ in.; the mouldings on each side, form the remaining two-sixths, or 6 ft. 0⅔ inches. From these measurements we have divided the compartment into a scale of six parts. Now the height from the capitals to the lower cornice of the triforium is according to our measurement 15 feet 2 inches. From this it is quite clear that it is composed

of five-sixths of the whole diameter, or 15 ft. 1⅜ in. as shewn by the quadrant, from figure 5 to *d*, whose centre is the point *a*.

The triforium, including its upper and lower cornices, is 8 ft. 3 in. in height, and is here so drawn. The arrangement of this dimension, as well as those of the clere-story, we were certainly at one time perfectly at a loss to discover, because neither the circle nor semicircle applies to them. Convinced in our own mind, that there was some positive law for the proportion of these parts, we tried if they could be produced by the junction of arcs, from the scale of six parts, with the perpendicular line dividing, or the line in the centre of each compartment, and the result of the investigation has been that the height of every proportion has been most accurately obtained. On each side of the compartment, a number of the same parts were added; those to the left are figured 7 to 12, and those to the right A. B. C. for distinction.—From the eighth point an arc, intersecting the boundary line of the compartment at *f*. gives the height of the triforium. From the tenth point, an arc whose radius is twelve parts of the scale, intersecting the same line at *g*., gives the termination of the bracketed columns of the clere-story. From the eleventh point, another arc, fourteen parts of the scale, intersecting the same line, determines the finish of the clere-story, and the commencement of the ancient semicircular ceiling. Above the bracketed columns the great rib of the ceiling, is perpendicular to the height of 5 feet 6 inches. This height is determined by the last arc.

The ancient ceiling, as shewn in Plate XXXVII. of the Illustrations, was perfectly semicircular; and, consequently, half the height of the width of the choir at that point, or 17 feet 1 inch. Let us now examine these various measurements with the whole height of the choir, which is 75 feet.

	ft.	in.
The columns are - - - -	18	6⅜
,, arches to the base of the triforium - -	15	2
,, triforium - - - -	8	3
,, columns of the clere-story - -	10	11
,, rib above them (straight) - - -	5	6
,, ceiling (half the choir) - - -	17	1
Total - - -	75	5⅜

The trifling difference in these measurements may be partly accounted

for, from the walls of the choir having been thrust outward by the modern ceiling, and the consequent depression of the rafters of the old one.

The theory for the formation of a compartment in exact proportion with the choir of Carlisle is, that when the perpendiculars A. A. (the distance between which being the width of the compartment) are given, all the different heights, excepting the columns, which are regulated by the square of the width, are determined by the intersection of arcs (upon the perpendiculars), whose radius is regulated by the continuation of a scale of six parts of the space between A. A.

The elevation of some compartments of other Cathedrals has been examined, with a view of finding how far the scale laid down for the production of Carlisle might agree with them, more particularly as it may be thought by many persons that the measurements of that building may have been arranged to suit the theory of the scale of parts; and, as the result of the enquiry, the elevation of one compartment of the presbytery of the choir of Worcester Cathedral, traced from Britton's Worcester Cathedral, Pl. VII., is subjoined by permission of Mr. Nattali, the proprietor of that work. Of the measurement of this building the author of this treatise knows nothing.

The same scale of parts (six of the width) which produces Carlisle, applies to Worcester; and as the proportion of the two specimens materially differ, the application of the same scale to two buildings hundreds of miles apart, measured by different parties, and, with the exception of the principal arch, totally at variance in their proportions, appears highly confirmatory of the theory.

The mouldings of the great arch is the same as Carlisle, namely, two-sixths of the whole width; and the height between the columns and the base of the triforium is also the same, namely, five-sixths of the width, as shewn by the quadrant from the fifth point to the letter K, although the arch is not equilateral.

With regard to the triforium, an arc struck from point 9, and composed of twelve parts of the scale, (see *c*), gives, where it intersects the line A. at *l*, the height of the columns of that part; and continuing the same arc beyond *l* to *m*, it gives, upon the junction of the perpendicular B, the whole height to the base of the clere-story.

By an arc, increasing four parts of the scale, (from points 11 and *e*), to

the perpendicular B at *n*, it gives the height of the clere-story columns. Another arc of twenty-two parts of the scale, (points 16 and *f*), gives the total height of the groining at *o*. At Carlisle, as before mentioned, the height of the semicircular ceiling of wood was regulated by the width of the choir, and consequently not affected by the scale, as is the case with Worcester.

The height of the main columns at Worcester are not the square of the width, as at Carlisle; and the difference appears to have no divisible part of the width, the height being rather more than one-seventh of the width. By striking an arc from point 10 upon the perpendicular A, its intersection with that at B at once decides the height. Thus we see that not only does the scale of parts regulate the portions above the columns, as at Carlisle, but it absolutely determines the height of the column itself.

It should be observed that the compartments of Carlisle and Worcester here brought forward are specimens of architecture of nearly the same period, and that, therefore, the guiding principles of each may be naturally supposed to be similar. How far the rules applied to these may regulate other buildings of a later date we do not pretend to say: it is for those who have the time and means at their disposal to examine and endeavour to elucidate their principles, and thereby lay a foundation to raise the character of our architecture and architects, and to avoid the stigma cast upon the evident failure of the mass of modern Gothic architecture, owing to the ignorance of the laws which guided our *Goths* of ancestors in those productions, which, with all our boasted advancement in science, we have been hitherto utterly unable to equal.

It has been used as an argument in favour of modern buildings, when the grandeur of our ancient piles are contrasted with their meagre appearance, that we have not the same means (i. e. money), to dispose of in their erection or decoration. This may be partly the cause; but the principal reason has been the ignorance of the architect of the leading forms and proportions which characterize the different styles of Gothic architecture. We have plenty of gingerbread ornament on buildings of our own time; but no dress ever did hide a bad form, and the more we attempt it the more we fail.

With one more example which incontestably proves the existence of geometrical law to regulate the design, we shall for the present conclude, not from the want of materials for carrying this subject much further, for it is inexhaustible. We allude to the east end of the Cathedral, the gem of the

building. By examination it will be found that an equilateral triangle whose base is the whole width of the Cathedral, comprised the total height of the east end to the point of the gable. This cannot be refuted, and if it were attempted, we could refer triumphantly to the upper window in the gable, where that form is repeated four times. (See Pl. II. figure 2.)

Although it may be as well to avoid the question of symbolical forms, the idea that this window was intended to convey a type of the unity of the Trinity, all coequal, neither superior nor inferior, so forcibly strikes the imagination, that we cannot refrain from expressing our belief that the Architect designed it with that intention.

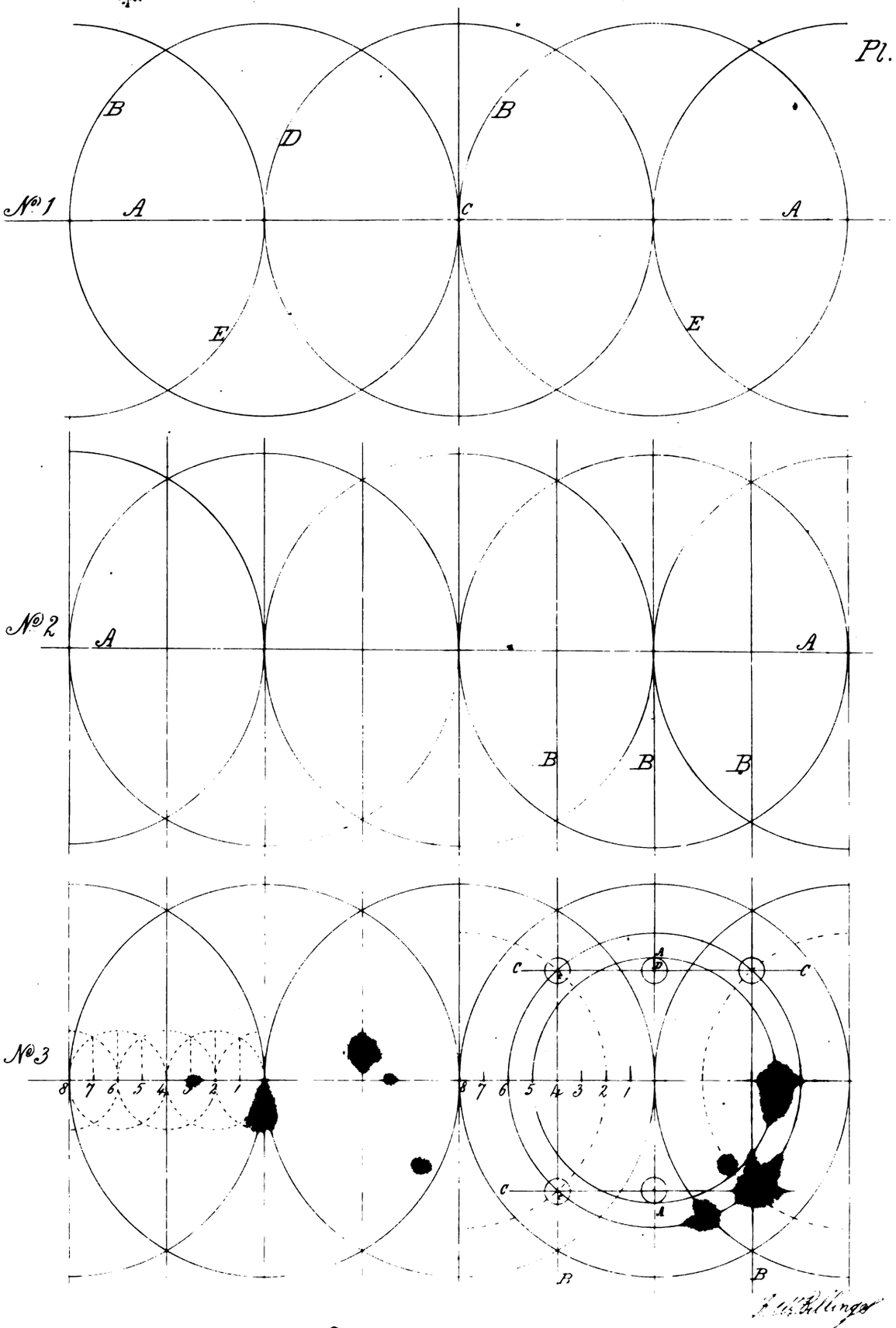
If we find so much system and harmonious proportion in the apparently mis-shapen and dismantled, but venerable Cathedral of Carlisle, what may we not expect to elucidate from the more perfect and gorgeous specimens scattered all over the country.

It is not by blindly copying the works of our predecessors, as we have hitherto mostly done, without being acquainted with the causes by which they produced such splendid effects, that we shall ever attain anything like their perfection, and we must therefore patiently endeavour to attain that object.

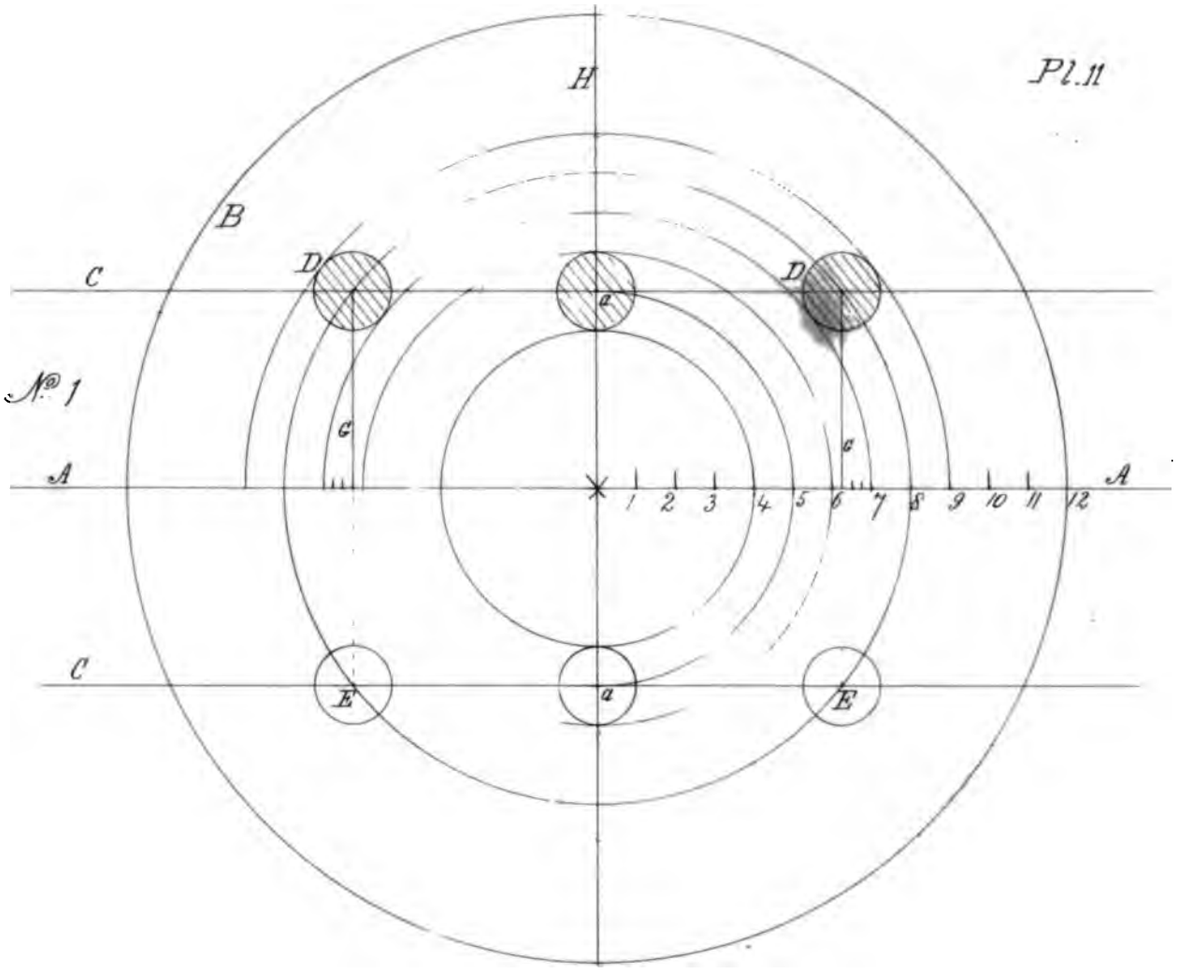
It has been objected to what is advanced in this paper that it would be a pity to fix any law for the proportions of Gothic buildings, or render any proportions arbitrary, as tending to cramp the genius of the Architect. This would be all very well, were we all Michael Angelo's or William of Wykeham's; but would it not be better for Modern Gothic Architecture, if in its leading forms, it had some recognisable laws instead of being altered, as it frequently is, at the caprice of individuals who know nothing of the matter? Although, in the case of Carlisle, rules are laid down for fixing the general proportions, there is just the same unbounded field for the genius of the Architect in the design of the enrichments of the various parts of another building, as there is in the execution of a beautiful draped figure from a skeleton.

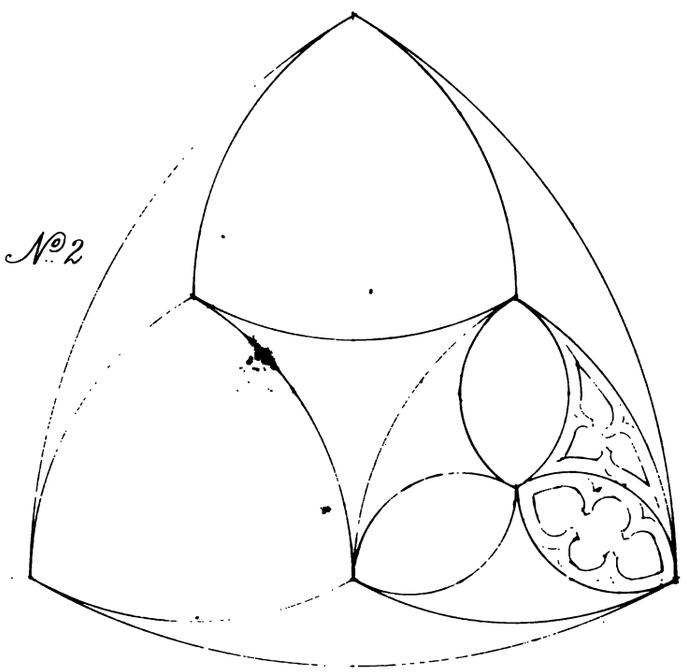
G. NORMAN, PRINTER, MAIDEN LANE, COVENT GARDEN.

Pl. 1



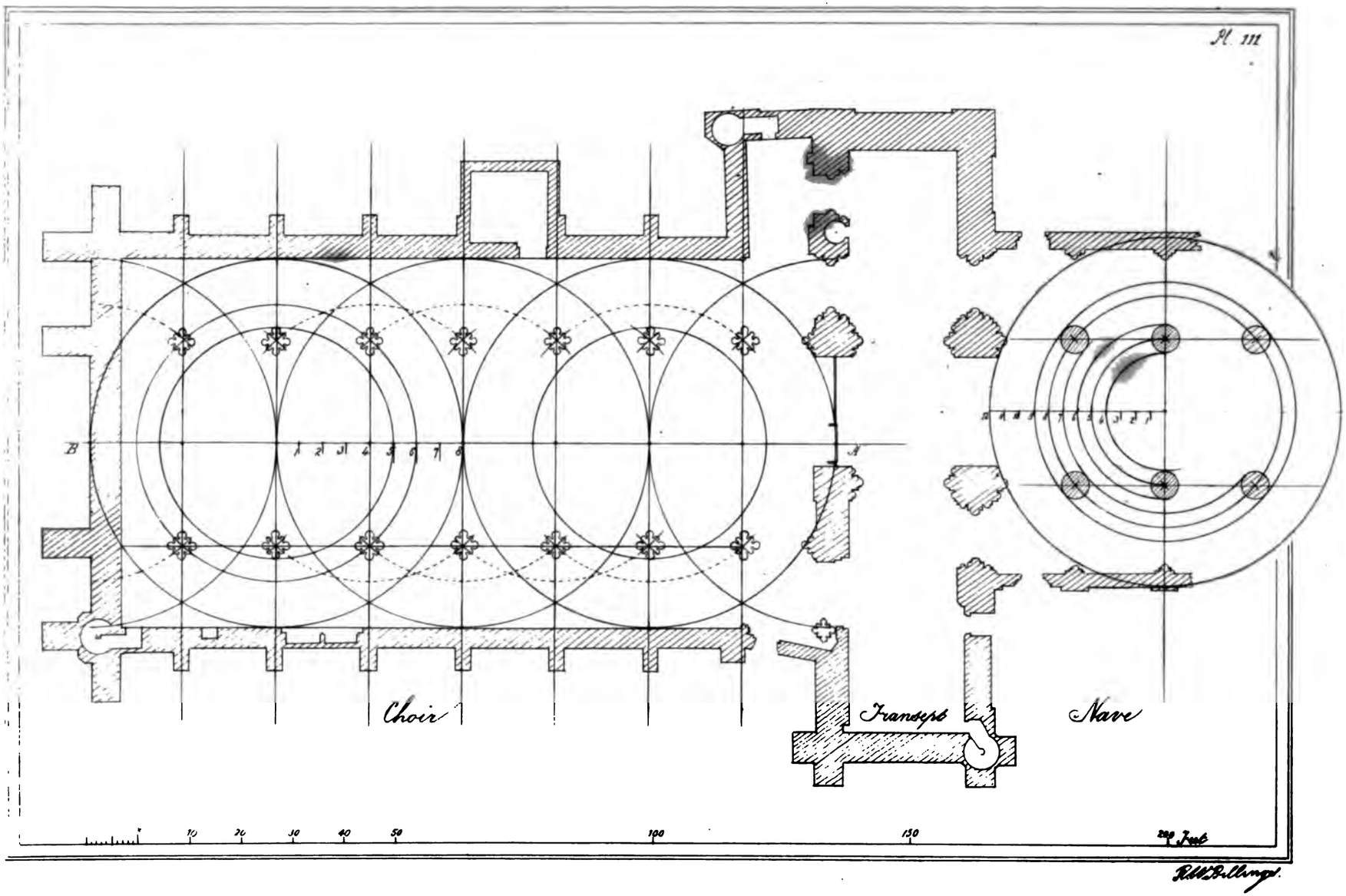
Pl. II



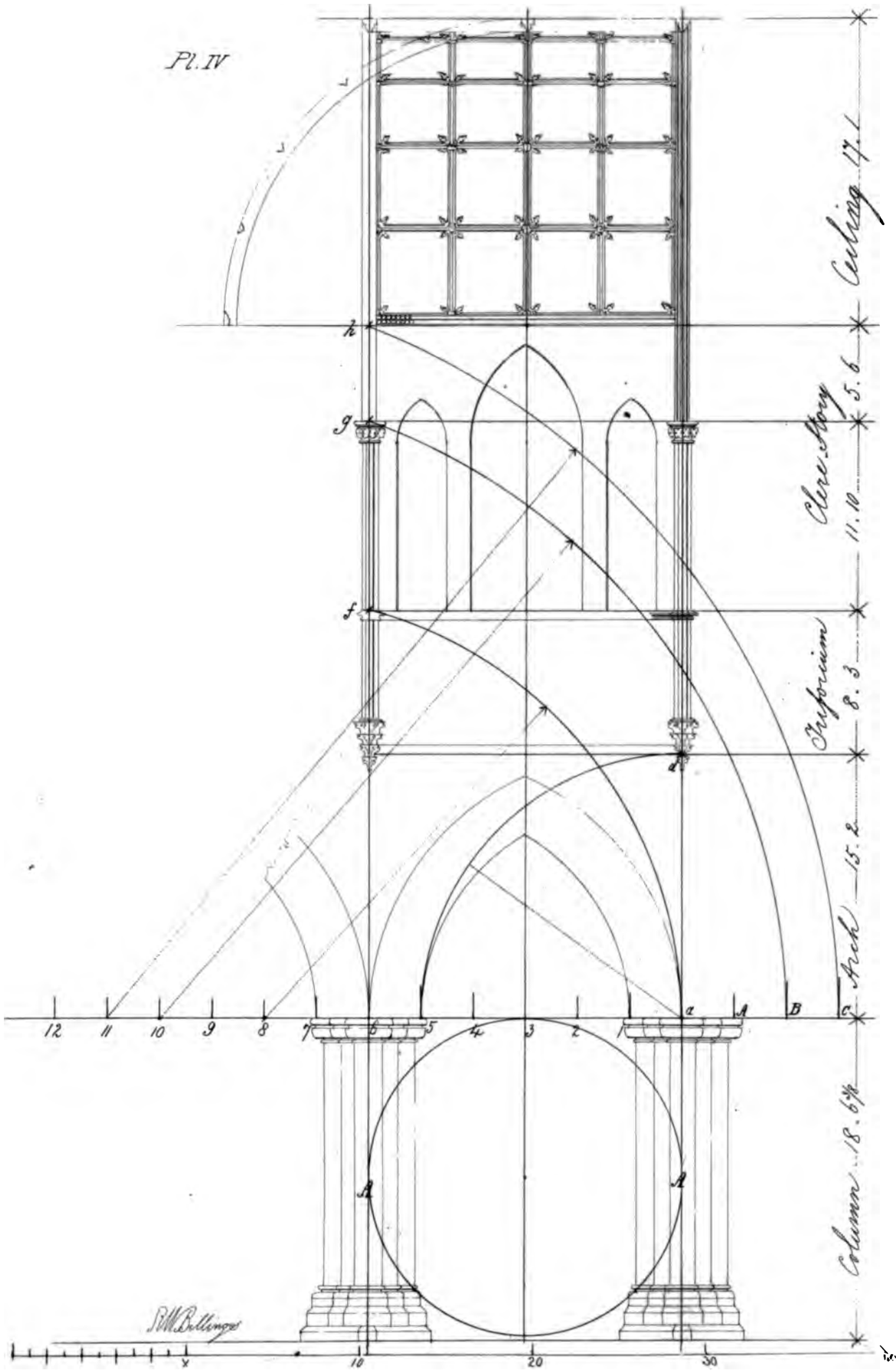


L. C. Billings

Pl. III



R.W.Billings.


Pl. IV
Ceiling 17. 1
Clere. Story 5. 6
11. 10
Triforium 8. 3
15. 2
Arch
Column 18. 6½
h
g
f
d
a
A
B
C
12
11
10
9
8
7
6
5
4
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2
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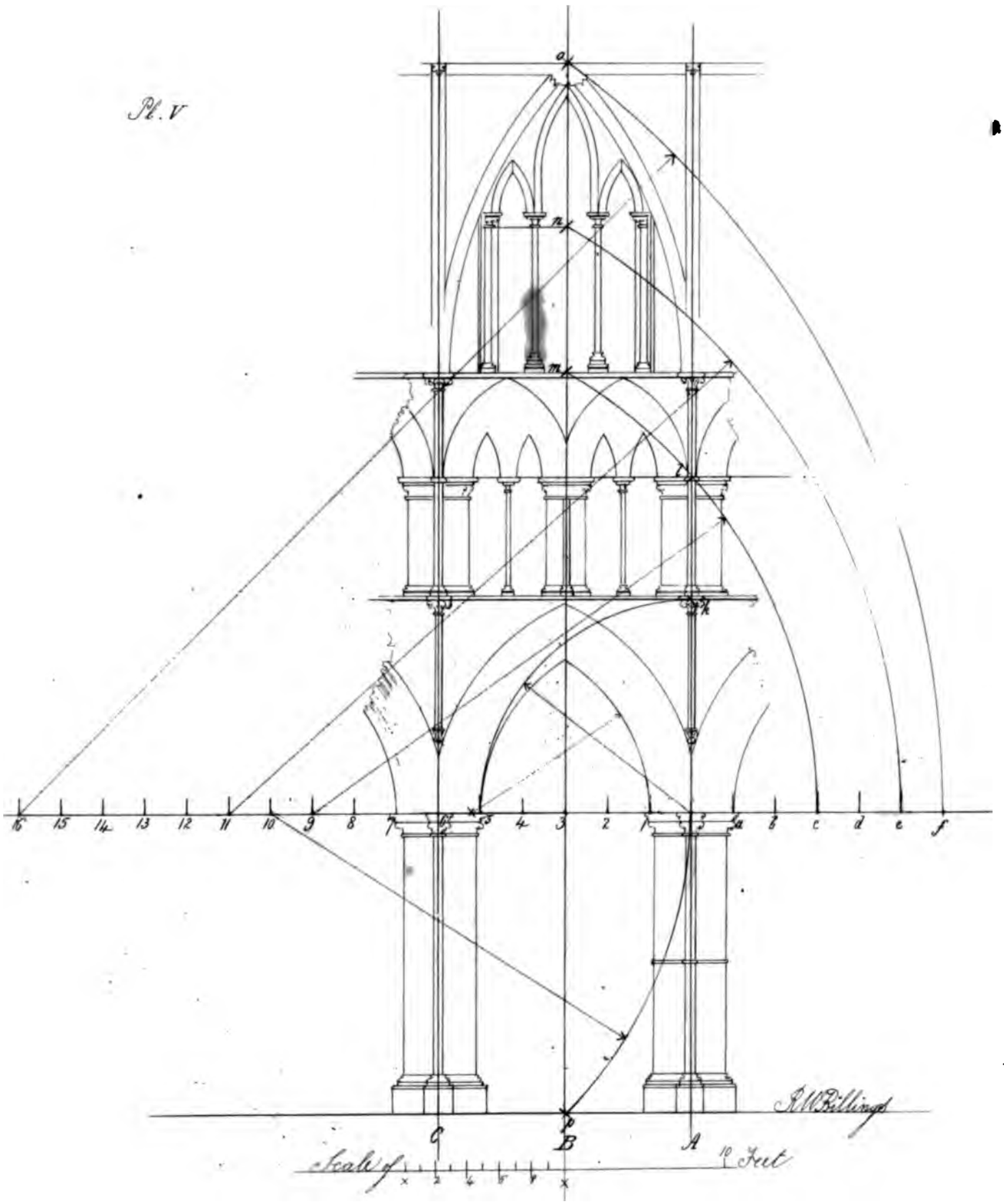
Pl. V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16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 a b c d e f
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R.W. Billings